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7. Abstract

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INTRODUCTION

SCOPE

This report summarizes and documents the results of the radiological surveys conducted over the Columbia River shoreline area of the 100-KR-4 Operable Unit, Hanford Site, Richland, Washington (Figure 1). In addition, this report explains the survey methodology using the Ultrasonic Ranging and Data System (USRADS) and the manual survey methodology used for a subarea of the shoreline area surveyed.

The 100-KR-4 radiological survey field task consisted of two activities: (1) characterization of the operable unit-specific background conditions and (2) the radiological survey of the operable unit shoreline surface area.

The radiological survey of the 100-KR-4 Operable Unit shoreline and the background study, were conducted by 100 Areas Restoration and Remediation Health and Safety Organization of the Westinghouse Hanford Company (WHC). The majority of the survey methodology was based on utilization of the USRADS for automated recording of the gross gamma radiation levels at or near 6 in. and at 3 ft from the surface soil. The area between the KE and KW Reactors river pumphouses was surveyed by manually logging the data from these gamma instruments at the same geometry relative to the soil surface.

Due to various factors such as survey speed, sparsity of coverage, and changing detector geometry, the sodium iodide (NaI) counts per minute data acquired are primarily nonquantitative and should not be interpreted to meet radiological release criteria.

PURPOSE

The purpose of the survey was to validate the results of the 1988 Edgerton, Germeshausen, & Grier, Inc. (EG&G), Idaho, flyover radiation survey and to identify the location of unidentified subsurface radioactive material areas and any surface contamination associated with these areas.

PROCEDURE

The radiological surveys were conducted following the procedures contained in the *Heath Physics Procedures Manual* (WHC 1991), in particular, Section 11.20.02, Ultrasonic Ranging and Data System (USRADS): Connecting the Equipment, Rev. 0; Section 11.20.01, Ultrasonic Ranging and Data System (USRADS): Equipment Setup, Rev. 0; Section 1.25.13, Ultrasonic Ranging and Data System (USRADS): System Calibration, Rev. 0; and Section 11.20.03, Ultrasonic Ranging and Data System (USRADS): Performing the Survey, Rev. 0.

The radiological surveys were conducted using a digital count rate meter with a NaI detector reporting in counts per minute and a dose rate meter reporting microroentgen per hour (μR/hr). The count rate meter was set for gross counting, i.e., window "out". The window setting allows detection of low, intermediate, and high energy photons.

For the survey of the area downstream of the KE river pumphouse, these instruments were connected to a CHEMRAD Tennessee Corp., Series 2000 USRADS. The USRADS equipment is used to record the detector readings verses the location of the readings, generate a map of the survey area, and save the data on computer storage media.

The area between the KW and KE river pumphouses was inaccessible to the USRADS support vehicle and was surveyed by manually logging the radiation/ contamination detection instruments output.

LOW BACKGROUND SURVEY

The low background survey was conducted to establish baseline radiological background conditions in a designated test plot known to have no history of radiological operations. The radiological data collected during this survey is considered representative of the undisturbed soil surfaces in the 100 Areas of the Hanford Site. The survey was conducted on July 17, 18, and 19, 1991.

LOCATION

The low background test plot, shown in Figure 2, is located in the 600 Area, between the 100-D/DR and 100-H Areas, approximately 2,000 ft from the Columbia River. The site had been previously staked on 100-ft intersects oriented along a north-south axis. The total size of the background plot is 500 by 500 ft.

DESCRIPTION

The survey was conducted using a Ludlum (tradename for Ludlum Measurements, Inc., Sweetwater, Texas) Model 2221 digital rate meter with a Ludlum Model 44-2, 1- by 1-in. NaI detector and a Ludlum Model 19 μR meter. The meters were coupled to the USRADS for the purpose of recording the data from the output of the individual detectors verses the location of those data within the survey area.

Seven individual surveys were performed to completely cover the 250,000 ft^2 site. A total of 5,796 data points were collected in this site. A summary of the survey results is provided in Table 1. The survey grid layout and a composite track map of the survey area are shown in Figure 3. Each grid block was traversed on approximately 25-ft transects.

Table 1. Low Background Survey Statistics.

SURVEY	DATE	GRID	DATA PTS	MAX CPM	MEAN CPM	SIGMA	MAX uR	MEAN uR	SIGMA
2a	07/16/91	a	861	3960	2437.63	404.04	14.42	9.67	1.72
2b	07/17/91	b	1320	3480	2417.45	367.39	15.62	9.58	1.81
2c	07/17/91	c	792	3540	2335.23	381.49	13.82	9.4	1.57
2d	07/17/91	d	755	3840	2409.93	402.36	16.52	9.88	1.77
2e	07/18/91	e	804	3660	2371.79	391.61	14.42	9.35	1.88
2f	07/18/91	f	668	3540	2331.65	416.68	13.82	9.18	1.62
2l	07/19/91	l	596	3540	2454.77	370.66	13.82	9.53	1.73
		TOTAL	5796	MEAN	2394.06		MEAN	9.51	

As the surveyor traverses the survey area, the USRADS records the output data from the radiation detector verses the location of where in the survey area the data was detected - each second. Therefore, while the survey is in progress, a real-time map of the survey area is generated. When the survey is completed, the survey data set is saved on a computer disk.

The background count rate was established by averaging the mean count rate for each survey. Using the formula: $BKGD=\Sigma X/7$, the average background count rate for the low background site was calculated to be 2,394 counts per minute and the average dose rate to be 9.51 uR/hr.

The minimum detectable count rate (MDCR) was then calculated by employing the formula:

$$2m\sqrt{(\frac{Rb}{Ts})+(\frac{Rb}{Tb})}$$

where:

Ts = gross sample count time (minutes)
Tb = background counting time (minutes)
Rb = background count rate in counts per minute
M = 1.645 (constant for 90% confidence level)

Based on the formula above, the minimum detectable count rate was 1,763 plus 2,394 counts per minute = 4,157 counts per minute.

One of the features of the USRADS is the ability to enter a "Threshold" setting on initiating a survey. The threshold setting is a value that when exceeded, the data point plotted on the central processing unit (CPU) monitor is highlighted. This feature alerts the CPU operator that the CPM data have exceeded the threshold, or preset value. For the purpose of conducting the 100-KR-4 remedial investigation/feasibility study (RI/FS) surface radiation survey, it was desirable to establish a value for the threshold where readings above the setting could be considered for further investigations. The threshold value established for the entire 100-KR-4 site survey was 3,900 counts per

minute. This value is practical base on the premise that too low a setting would highlight normal fluctuations above the calculated mean, and too high a setting would cut off the low end of surface radiation that might be present.

SHORELINE SURVEY

A distance of approximately 6,172 ft of shoreline was surveyed with the USRADS equipment. Within this area, a total of 21,880 data points were collected. Each of these data points represents two gross gamma radiation readings, counts per minute with a NaI detector at 6 in., and a dose rate with a μR meter at 3 ft, along with the physical coordinates of the readings. A total of 41 individual surveys were conducted to complete the 6,172 ft of shoreline area. The shoreline from the K-42 stake upstream to the KE pumphouse, a distance of approximately 30 ft, was not surveyed due to the placement of large boulders (rip rap) in this area making it unsafe to traverse.

The shoreline area between the KE and KW river pumphouses was inaccessible to the USRADS support vehicles due to a large surface contamination area located on the flood plain and extremely steep rocky terrain near the river's edge. This approximately 1,700-ft-long area was surveyed with the same gamma detecting instrumentation at the same distances from the soil surface by manually logging the instruments output. In addition, this area was surveyed with GM/HP-210 instrumentation.

LOCATION

Prior to initiating the USRADS radiological survey of the 100-KR-4 Operable Unit shoreline, a grid system was established so that the individual surveys could be controlled and tied together. A starting point on the shoreline located north of existing Hanford Site coordinate benchmark (N148,395.73; E570,111.51) was selected and stakes were placed approximately 50 ft inland and at 150-ft intervals upstream from this point to the KE river pumphouse. The area between stakes defined a grid and was given an alpha-numeric designation. Grid K1 is the area from stake K-1 upstream to K-2, grid K2 the area from stake K-2 upstream to stake K-3, and so on. For reporting purposes, the entire survey area was divided into subsections designated A through F. Figure 4 shows the grid system used. At the completion of the radiological survey phase of work, Kaiser Engineers Hanford conducted a civil survey of this area and provided a map and list of coordinates for each grid stake.

For reporting purposes, the area between the pumphouses was controlled by placing alpha-numeric designated stakes at 100-ft intervals starting at the upstream edge of the KE pumphouse and working upstream to the KW pumphouse. Figure 5 shows the placement of these stakes.

INSTRUMENTATION

Gamma Detection Instrumentation:

Ludlum Model 2221 Digital Scaler/Rate Meter, PNL No. 5580
Ludlum Model 2221 Digital Scaler/Rate Meter, PNL No. 5581
Ludlum Model 2221 Digital Scaler/Rate Meter, PNL No. 5582

Ludlum Model 19 μR Meter, PNL No. 5028
Ludlum Model 19 μR Meter, PNL No. 5029

These instruments are maintained and calibrated by Pacific Northwest Laboratory (PNL).

Radiation survey instruments were checked at the beginning of each day for the proper instrument response. This was accomplished by placing a cesium-137 or natural uranium check source next to the detector and observing the instrument's response to the source. Local background radiation checks were also performed by taking three 1-min counts.

SURVEY METHODOLOGY

MANUAL

This survey was performed by manually logging the NaI count rate meters digital scale reading and the Model 19's analog dose rate meter reading approximately every 10 ft along the shoreline edge. The NaI detector on the count rate meter and the Model-19 were held approximately 6 in. and 3 ft above the ground respectively.

Three passes with GM/HP-210 instrumentation on approximately 25-ft transects parallel to the rivers edge were also performed. Probe speed for the GM survey was approximately 1 ft/s at a distance of approximately 2 in. from the surface.

Statistically elevated readings were not observed with any of the utilized instrumentation. Table 2 gives the maximum GM count rate meter with model HP-210 probe counts per minute, maximum NaI counts per minute, and the average dose rate per each 100-ft section of shoreline surveyed between the two pumphouses.

USRADS

Each survey entailed setting up the USRADS equipment in a grid block; connecting the radiation survey meters to the USRADS data pack; calibrating the USRADS equipment and performing the survey. Calibration of the USRADS is performed prior to starting a survey. The purpose of the calibration sequence is to reestablish the positioning instrumentation after the equipment is moved to a new location.

Table 2. Manual Survey Statistics.

GRID	DATE	MAX CPM W/GM	MAX CPM W/NaI	AVE. DOSE RATE (uR/Hr)
K-43	3/5/92	125	1640	8
K-44	3/5/92	100	1511	7
K-45	3/5/92	100	1526	7
K-46	3/5/92	100	1531	7
K-47	3/5/92	150	1604	7
K-48	3/5/92	100	1667	8
K-49	3/5/92	100	1595	7
K-50	3/6/92	100	1687	8
K-51	3/6/92	100	1626	7
K-52	3/6/92	100	1623	7
K-53	3/6/92	100	1644	7
K-54	3/6/92	100	1474	7
K-55	3/6/92	125	1791	8
K-56	3/6/92	125	2000	9
K-57	3/6/92	100	2027	9
K-58	3/6/92	125	1733	8
K-59	3/6/92	100	1848	9

Every attempt was made to traverse each grid block on approximately 25-ft transects, however, due to the roughness of the terrain and varying vegetation growth this was not always possible. Speed of survey was approximately 1 m/s. The gamma detector was maintained about 6 in. from the soil surface by suspending the detector from a boom attached to the surveyors backpack. The dose rate meter was mounted to this boom 3 ft from the soil surface. In this manner, detector geometry remained relatively constant throughout the entire survey.

Statistically elevated radiation/contamination readings were not observed. However, in survey KR4k16A (for grid K16) there were three anomalous data points. These data points were at the end of the KR4k16A survey. This is an indication that the radiation detection instrumentation was turned off prior to the termination of data acquisition by the USRADS program. The flyover survey had identified a large portion of the K Area shoreline as slightly elevated radiologically. The USRADS survey does not substantiate this data. It is possible that what the flyover survey shows as

an elevated area on the shoreline is in reality "shine" from the K-facilities and/or burial grounds.

A summary of the radiological survey data for each grid block is given in Table 3. The survey summary for KR4K16A has been altered indicating the removal of the three anomalous data points.

A composite track map of the 100-KR-4 Operable Unit USRADS survey is shown in Figure 6. Figures 7 through 12 are composite track maps of each subsection to provide greater clarity and detail.

Table 3. USRADS Survey Statistics.

SURVEY	DATE	GRID	DATA PTS	MAX CPM	MEAN CPM	SIGMA	MAX uR	MEAN uR	SIGMA
KR4K1A	02/20/92	K1	456	2760	1630.39	327.08	11.42	6.8	1.55
KR4K2A	02/20/92	K2	432	2400	1495.28	307.86	10.22	6.21	1.59
KR4K3A	02/21/92	K3	687	2520	1616.24	322.98	10.82	6.44	1.41
KR4K4A	02/21/92	K4	414	2340	1522.03	281.64	9.32	5.86	1.49
KR4K5A	02/21/92	K5	648	2280	1436.3	297.47	10.22	6.19	1.46
KR4K6A	02/21/92	K6	580	2040	1348.76	286.06	10.82	5.73	1.46
KR4K7A	02/21/92	K7	625	2040	1268.74	286.6	10.22	5.61	1.36
KR4K8A	02/24/92	K8	829	3960	1476.04	322.31	10.52	6.09	1.44
KR4K9A	02/24/92	K9	841	2700	1578.55	305.45	12.02	6.71	1.56
KR4K10A	02/24/92	K10	603	2460	1504.78	322.98	12.02	6.43	1.52
KR4K11A	02/24/92	K11	467	2280	1437.43	334.38	10.22	5.94	1.48
KR4K12A	02/24/92	K12	444	2220	1359.19	300.48	9.32	5.67	1.36
KR4K13A	02/24/92	K13	563	2100	1395.45	292.6	9.92	5.77	1.36
KR4K14A	02/24/92	K14	626	2100	1380	277.86	11.12	6.04	1.5
KR4K15A	02/25/92	K15	615	2400	1514.34	336.55	10.52	6.25	1.46
KR4K16A	02/25/92	K16	534	2580	1521.61	293.24	10.0	6.52	1.43
KR4K17A	02/25/92	K17	450	2580	1497.2	312.3	9.92	6.52	1.51
KR4K18A	02/25/92	K18	541	2460	1569.09	334.36	10.82	6.66	1.59
KR4K19A	02/25/92	K19	427	2340	1430.87	339.15	10.52	6.29	1.48
KR4K20A	02/25/92	K20	519	2280	1384.86	285.62	12.02	6.04	1.47
KR4K21A	02/25/92	K21	434	2400	1495.71	320.52	10.82	6.79	1.43

Table 3. (Continued)

SURVEY	DATE	GRID	DATA PTS	MAX CPM	MEAN CPM	SIGMA	MAX uR	MEAN uR	SIGMA
KR4K22A	02/25/92	K22	602	2820	1613.82	379.45	11.42	7.16	1.59
KR4K23A	02/26/92	K23	576	2880	1699.69	345.69	11.12	7.68	1.69
KR4K24A	02/26/92	K24	609	2520	1662.56	341.93	12.32	7.35	1.81
KR4K25A	02/26/92	K25	440	2340	1537.77	330.88	11.42	6.74	1.64
KR4K26A	02/26/92	K26	520	2640	1481.19	320.86	11.72	6.34	1.71
KR4K27A	02/26/92	K27	427	2400	1462.9	354.59	12.32	6.4	1.68
KR4K28A	02/26/92	K28	406	2400	1417.54	330.35	10.52	6.09	1.57
KR4K29A	02/26/92	K29	478	2160	1328.28	297.78	11.12	5.73	1.6
KR4K30A	03/02/92	K30	580	2400	1453.34	311.36	10.52	6.35	1.38
KR4K31A	03/02/92	K31	595	2520	1414.08	305.92	9.62	5.79	1.42
KR4K32A	03/02/92	K32	477	2520	1343.9	325.7	9.62	5.57	1.49
KR4K33A	03/02/92	K33	379	2520	1497.63	351.11	9.92	6.11	1.65
KR4K34A	03/02/92	K34	419	2460	1541.67	323.36	10.22	6.25	1.53
KR4K35A	03/03/92	K35	518	2580	1571.35	311.92	12.92	6.7	1.7
KR4K36A	03/03/92	K36	377	2640	1677.29	387.12	12.62	7.08	1.96
KR4K37A	03/03/92	K37	368	2460	1666.79	338.21	12.02	7.26	1.75
KR4K38A	03/04/92	K38	674	2700	1696.38	334.82	12.62	6.26	3.1
KR4K39A	03/04/92	K39	727	2760	1640.3	348.37	11.72	6.99	1.69
KR4K40A	03/04/92	K40	449	2460	1558.13	318.85	11.42	6.62	1.51
KR4K41A	03/04/92	K41	521	2280	1515.78	274.11	10.52	6.71	1.59

Figure 1. 100-KR-4 Shoreline Survey Area.

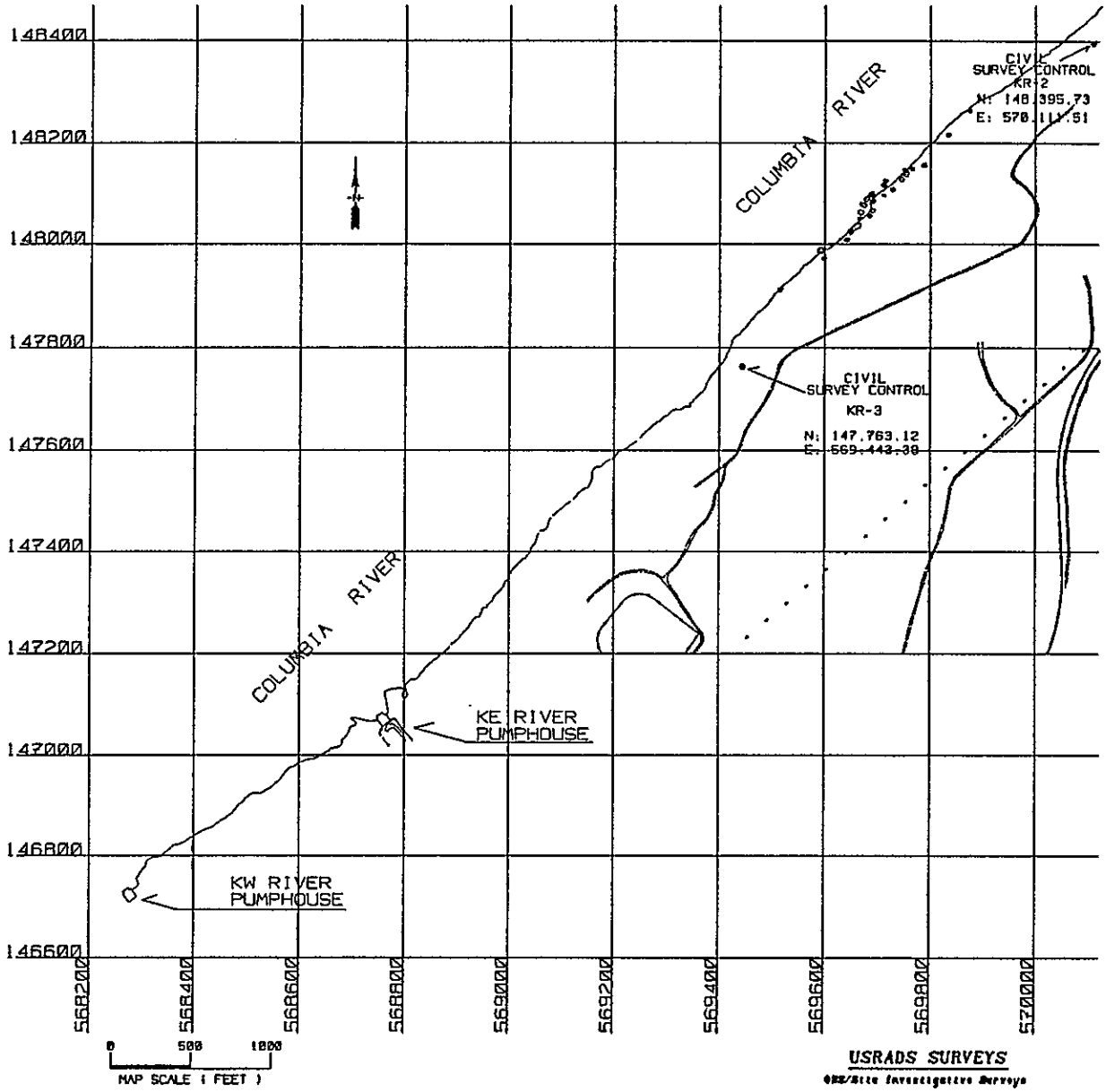

FIGURE 1

Figure 2. 100 Areas Low Background Site.

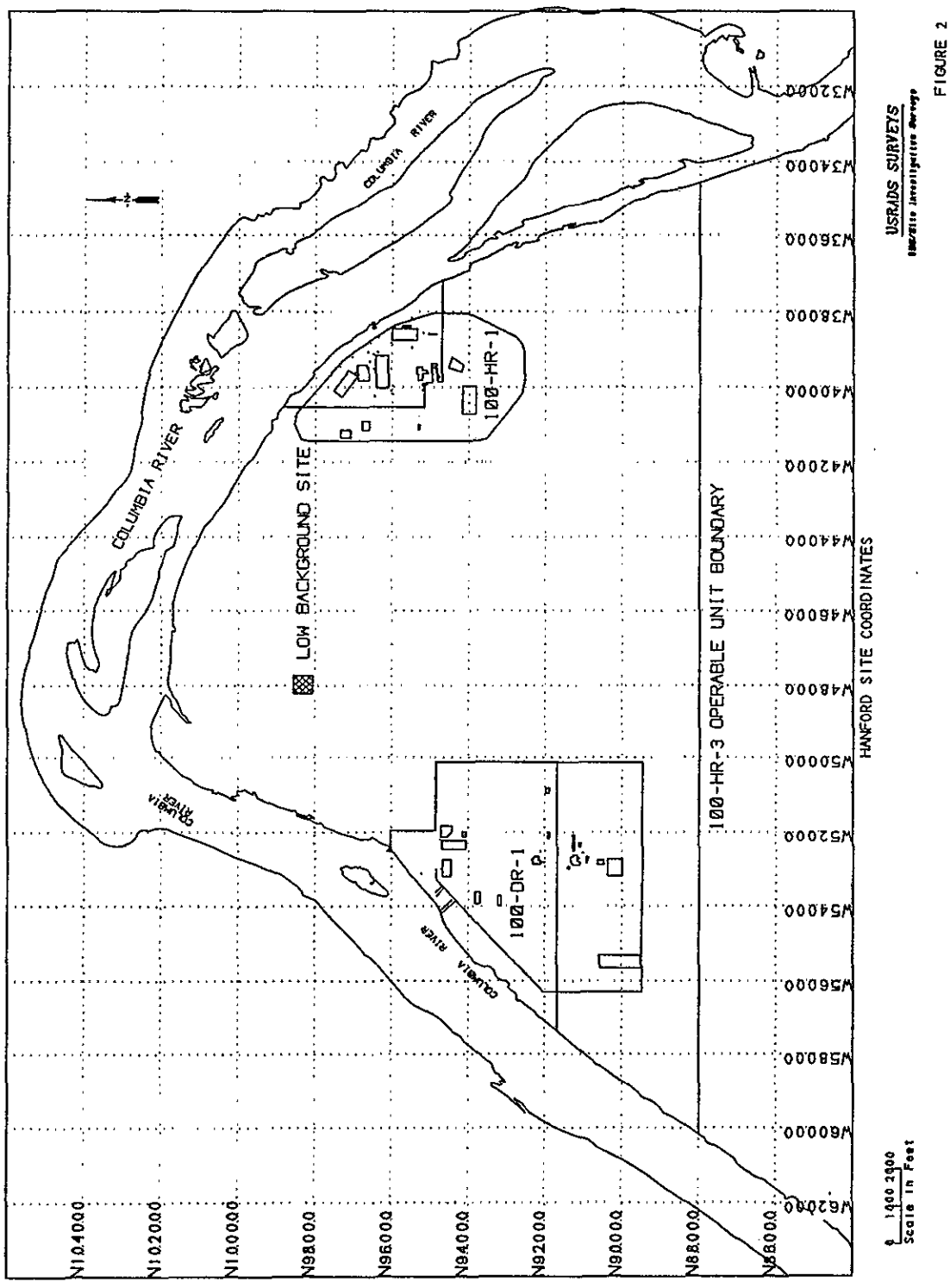

Figure 3. Low Background Site, USRADS Survey Composite Track Map.

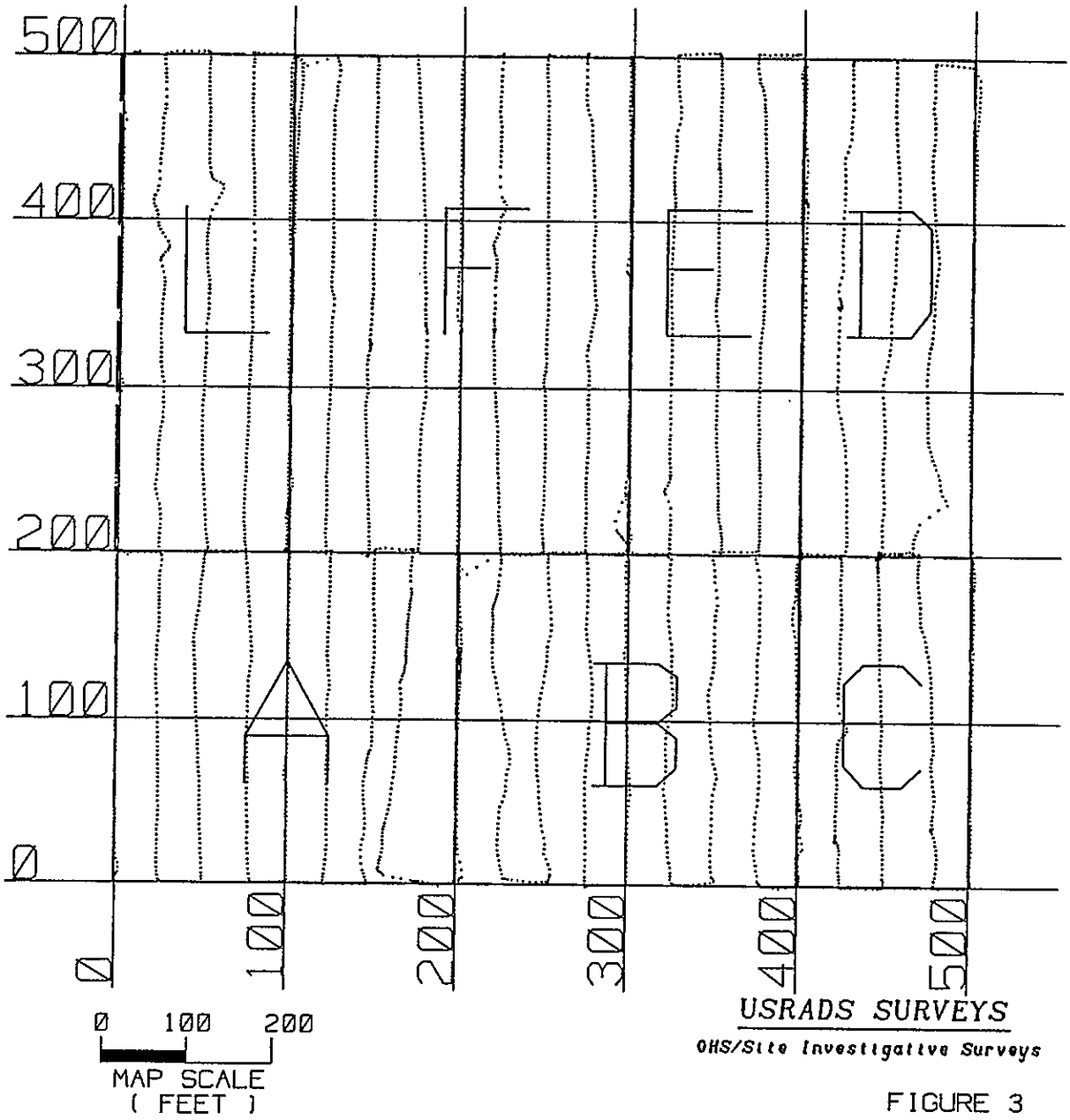

FIGURE 3

Figure 4. 100-KR-4 Subsection and Stake Location Map.

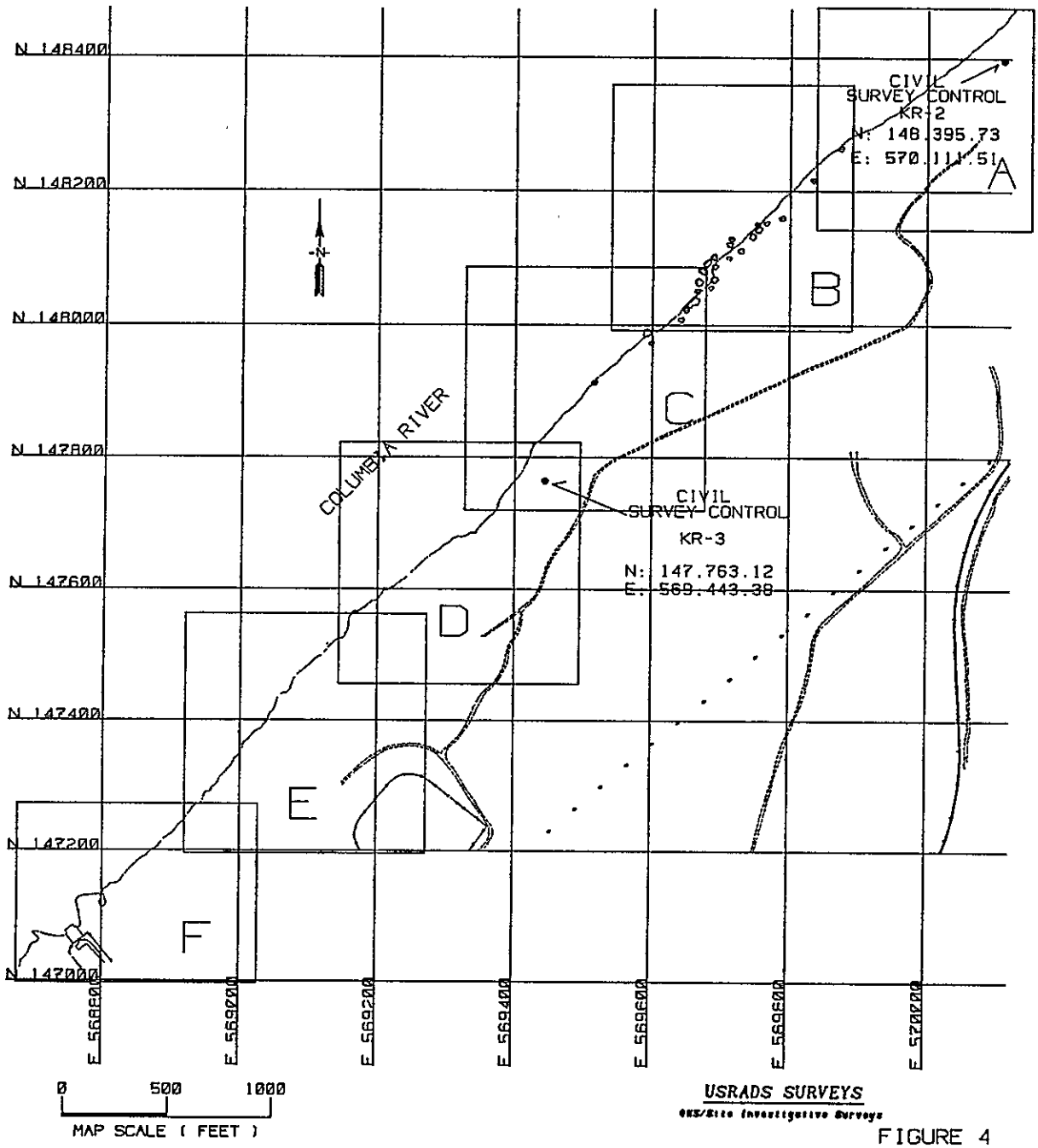

FIGURE 4

Figure 5. 100-KR-4 Stake Locations for Manual Data Logging.

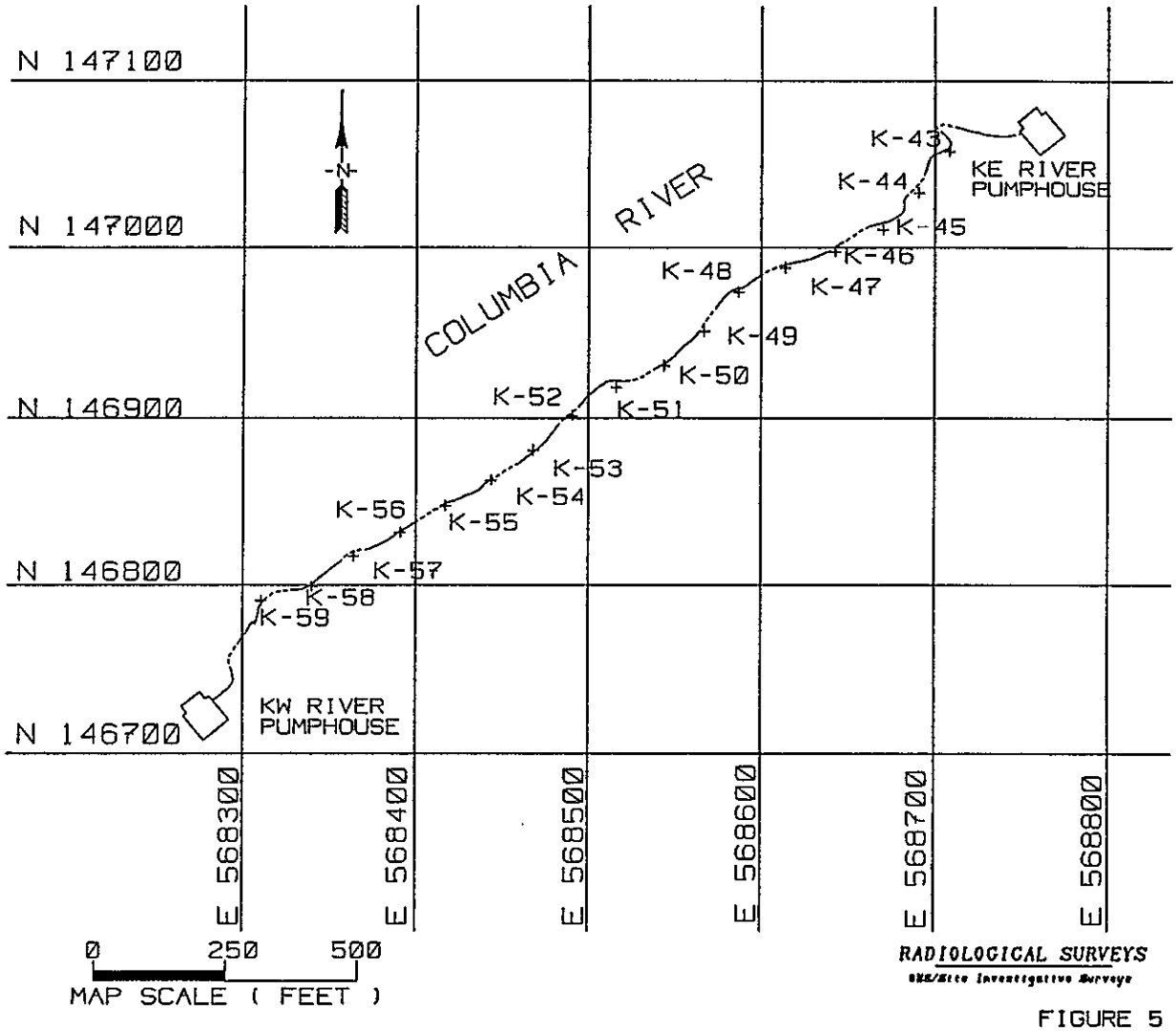

FIGURE 5

Figure 6. 100-KR-4 USRADS Survey Composite Track Map.

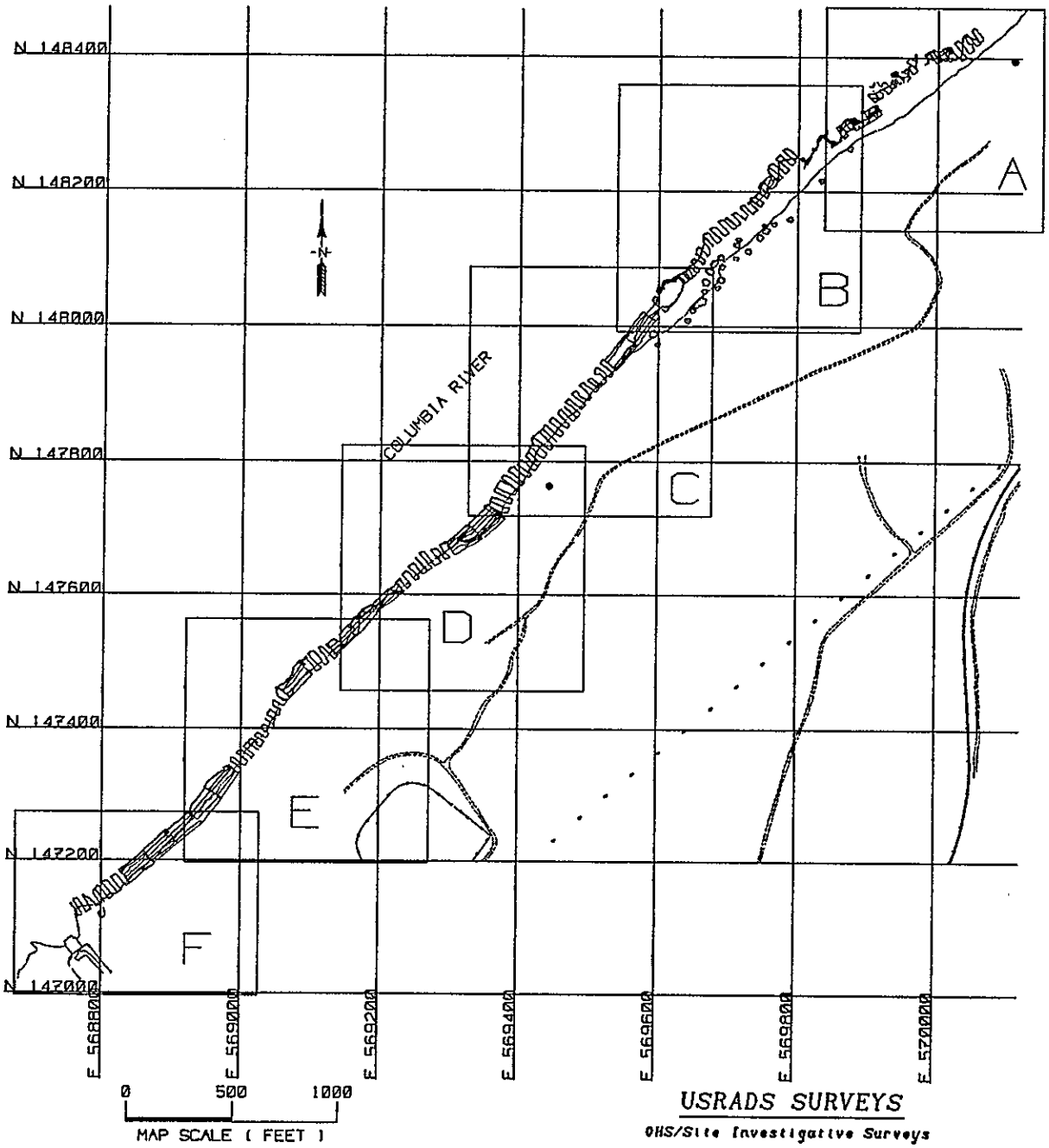

FIGURE 6

Figure 7. 100-KR-4 Section A Composite Track Map.

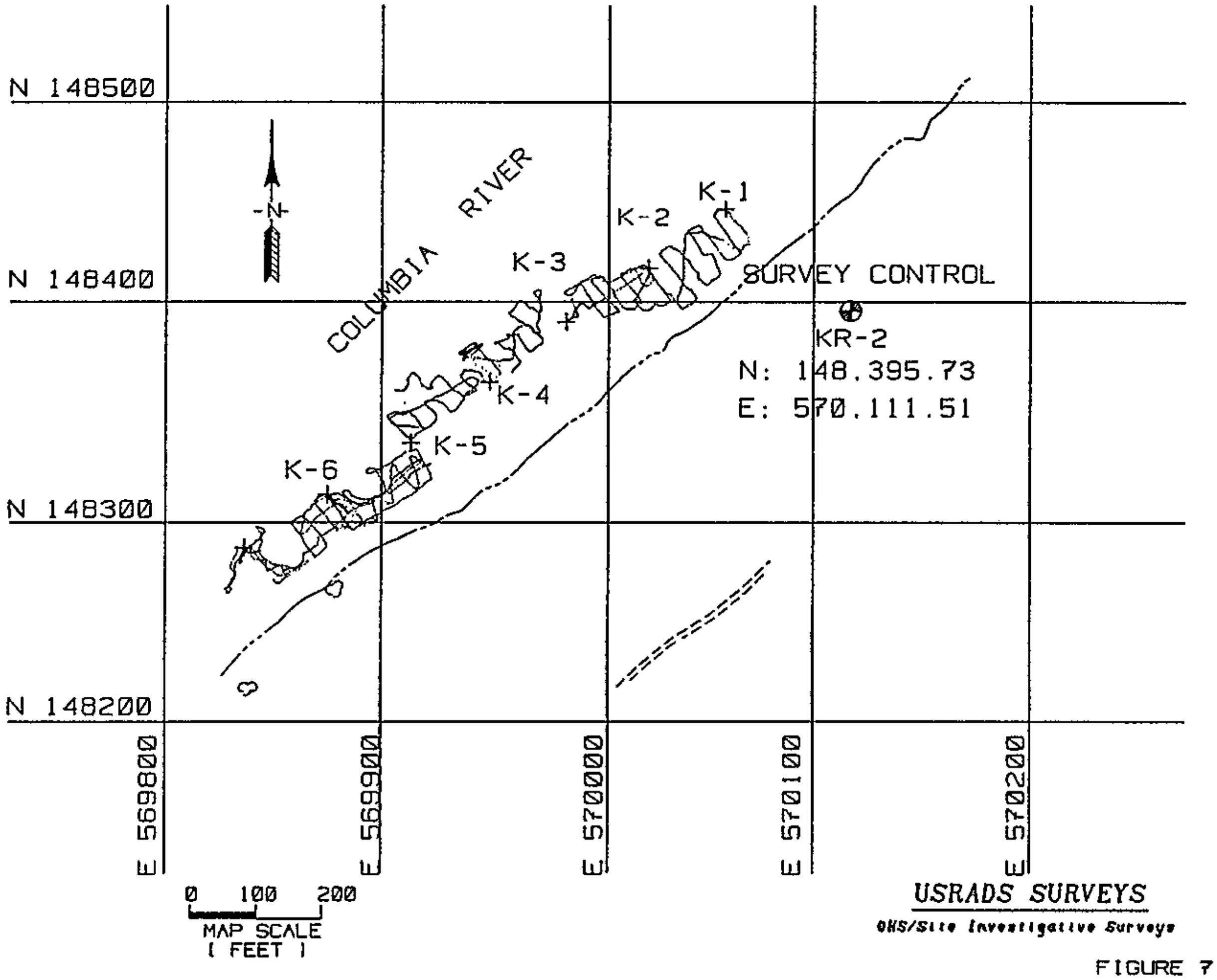

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Figure 8. 100-KR-4 Section B Composite Track Map.

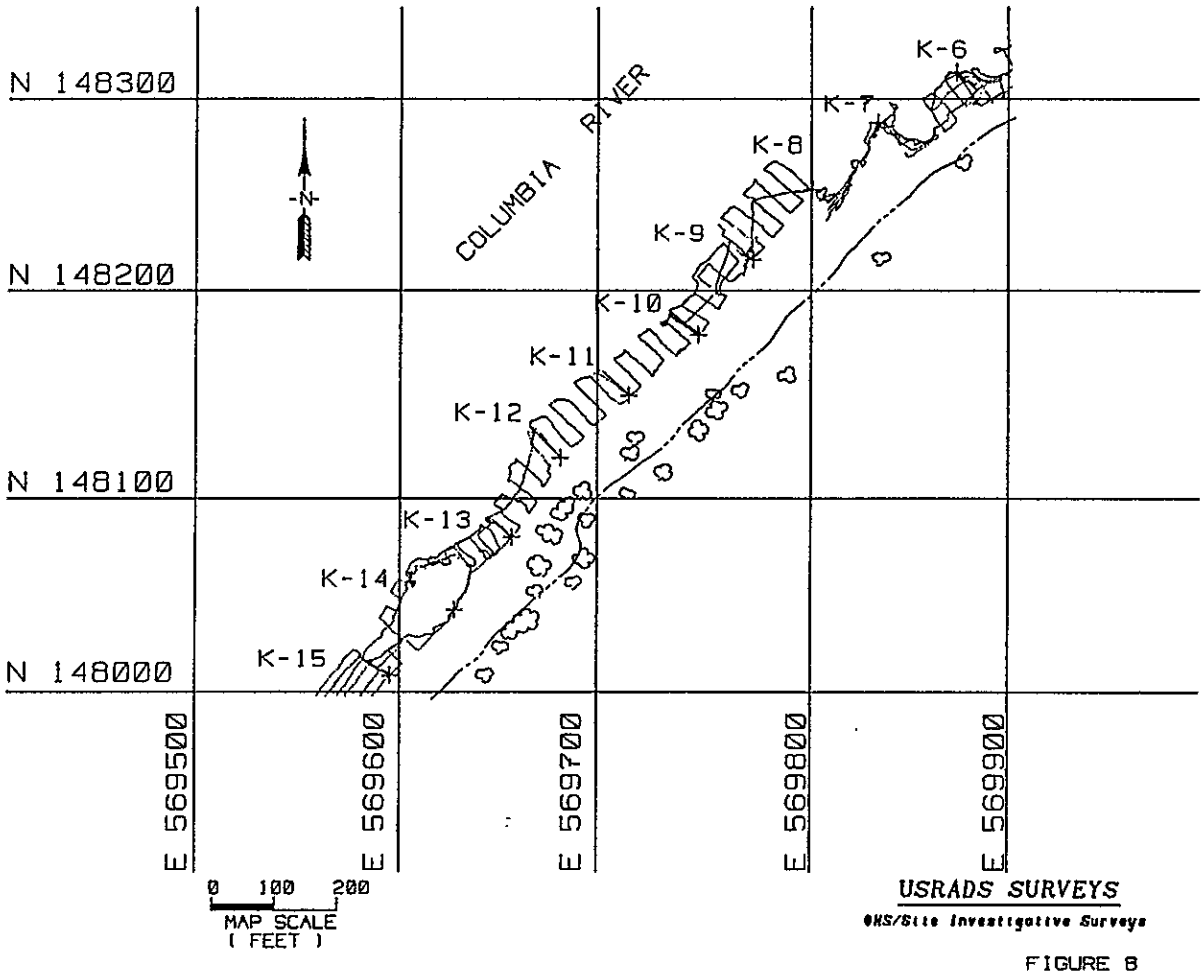


Figure 9. 100-KR-4 Section C Composite Track Map.

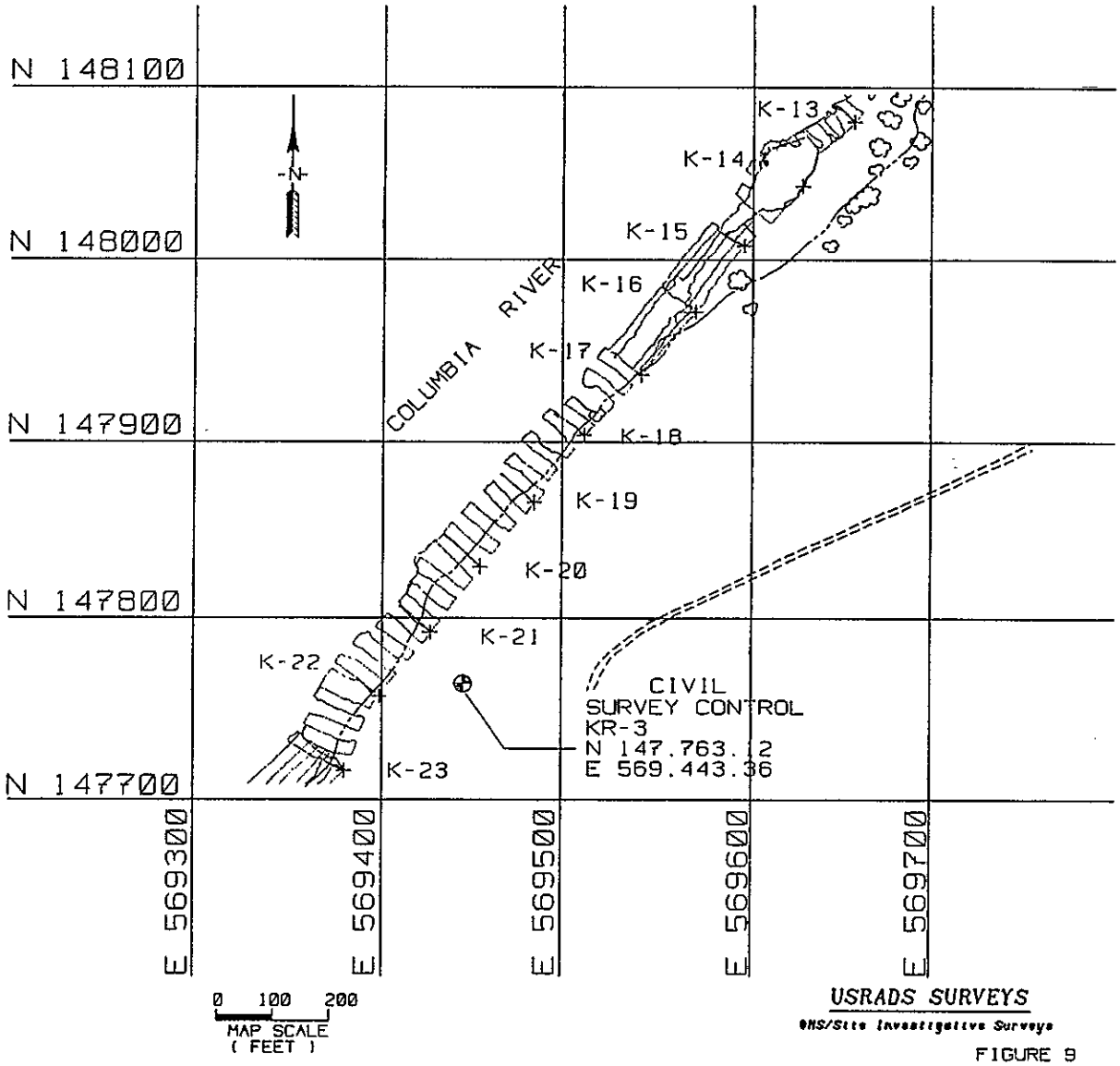


Figure 10. 100-KR-4 Section D Composite Track Map.

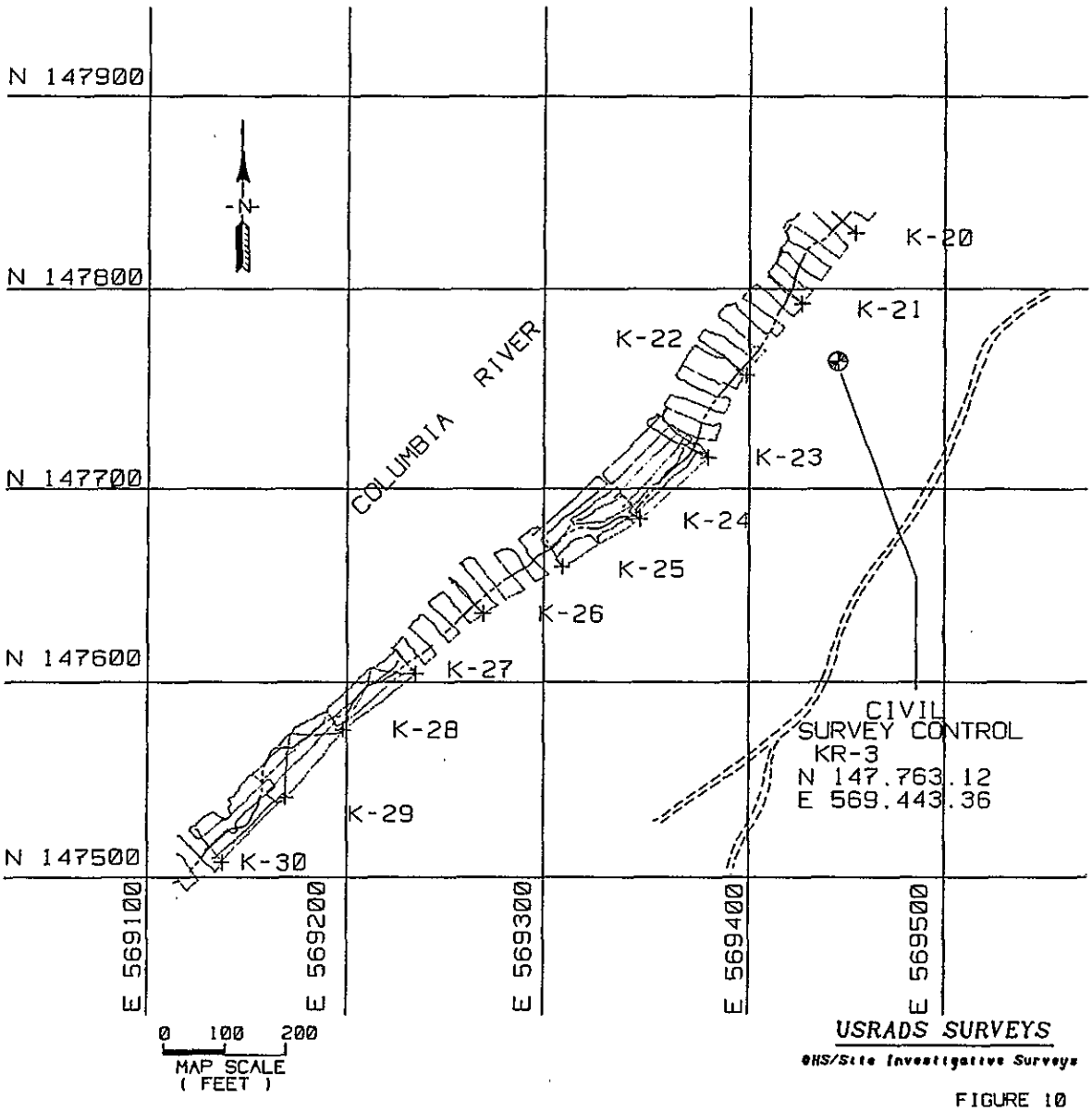


FIGURE 10

Figure 11. 100-KR-4 Section E Composite Track Map.

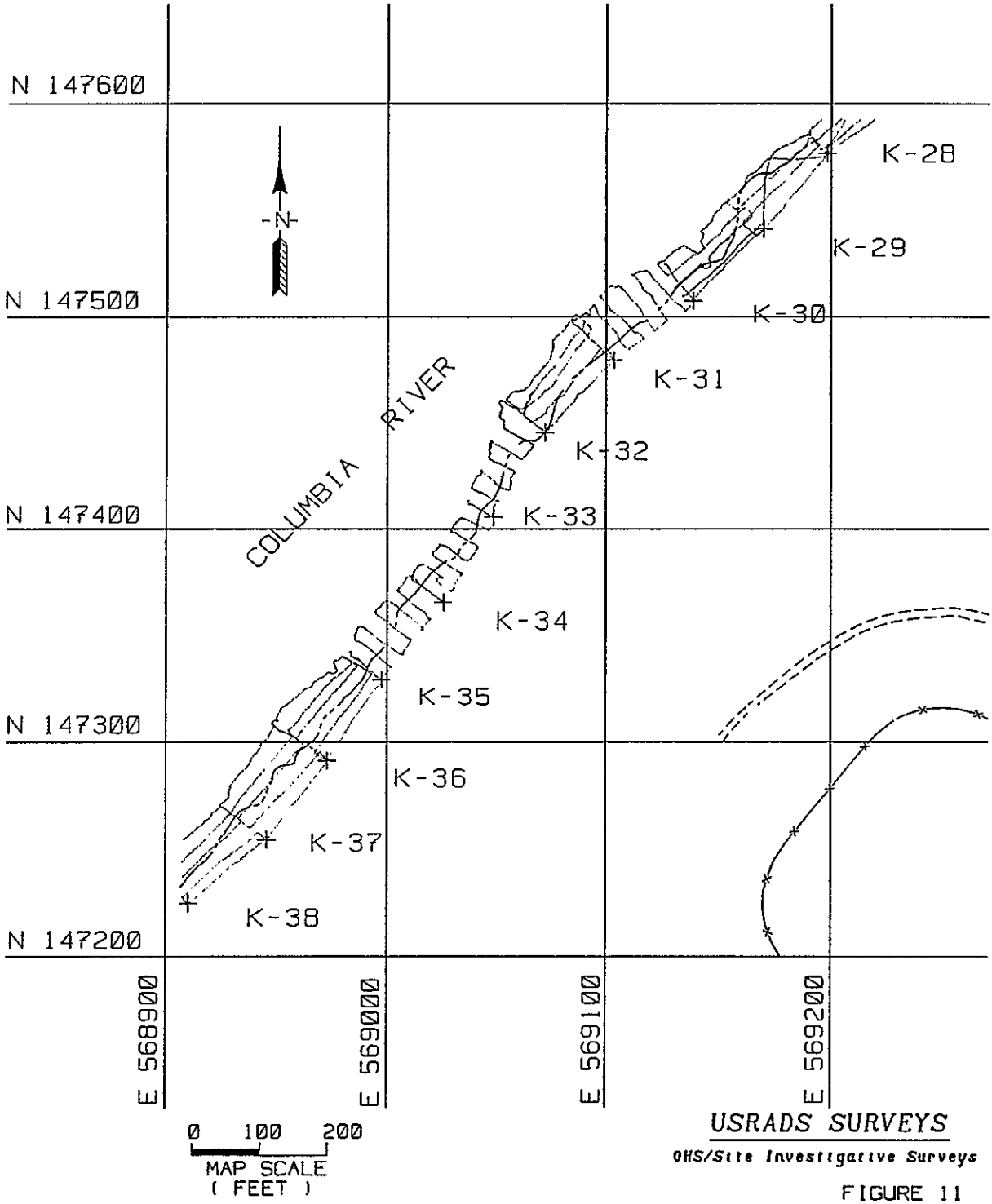
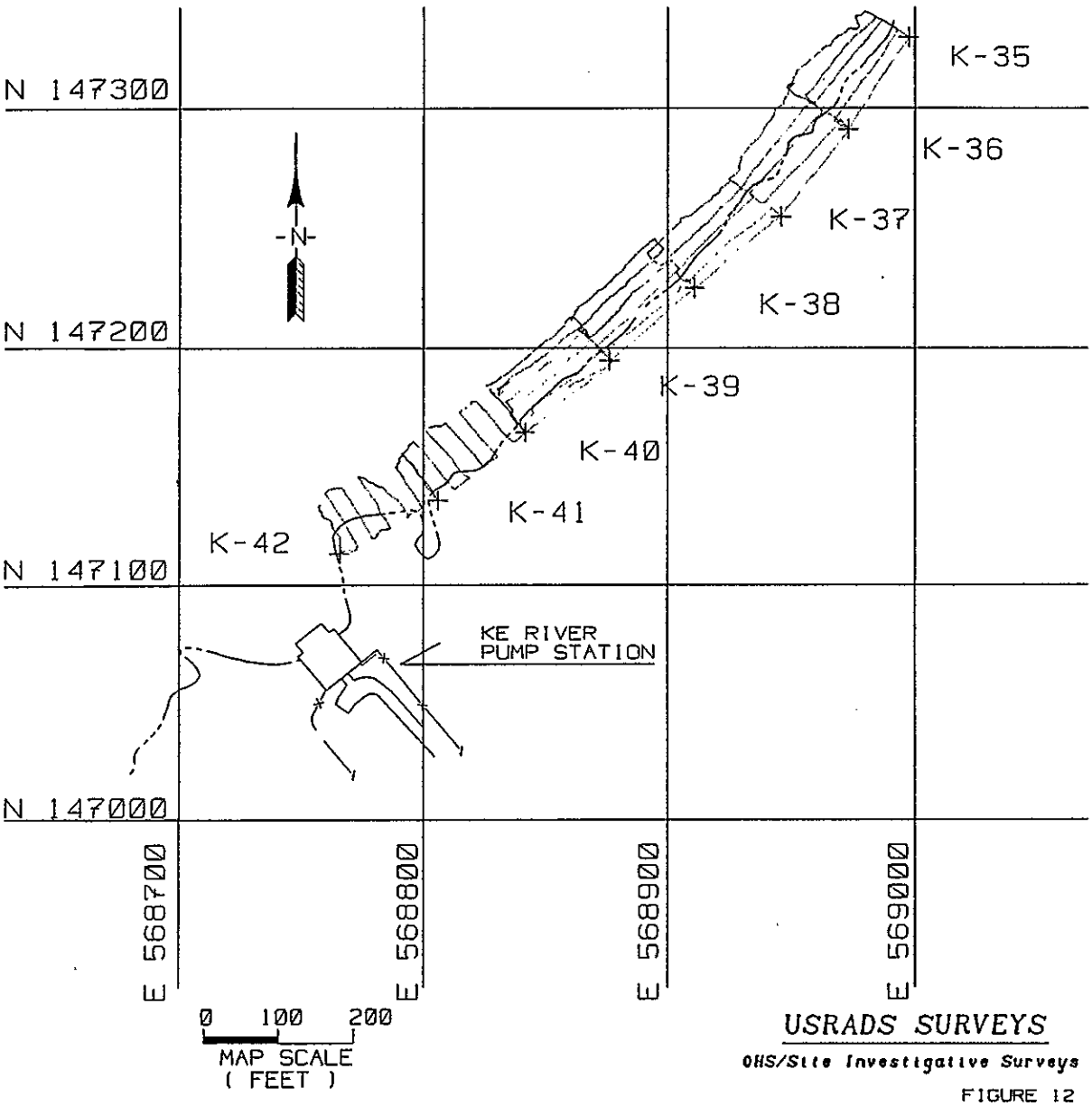


Figure 12. 100-KR-4 Section F Composite Track Map.



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